STRUCTURAL ANALYSIS AND DESIGN OF STEEL-FRAMED HOUSE WITH COLD-FORMED AND HOT-FINISHED RECTANGULAR HOLLOW SECTION

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by

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LIST OF ABBREVIATIONS

CDF	Cumulative distribution function
CFS	Cold-formed steel
Exp	Experimental
F	Flexural buckling
FEA	Finite element analysis
FEM	Finite Element Model
FT	Flexural torsional buckling
HRS	Hot-rolled steel
L	Local buckling
LSF	Light gauge steel frame
MAC	Modal assurance criterion
MTMAC	Modified total modal assurance criterion
Num	Numerical
RHS	Rectangular hollow section

LIST OF SYMBOLS

B	Distance between column and lower end brace
E	Elastic modulus
E_0	Initial elastic modulus
F_u	Tensile strength
F_y	Yield stress
G_k	Permanent action
H	Story height
h_c	C-section web depth
I_y	Second moment of area about y-axis
k	number of identified frequencies
$K_{\text{infilled frame}}$	Stiffness of infilled frame
$K_{\text{infill wall}}$	Stiffness of infill wall
$K_{\text{steel frame}}$	Stiffness of steel frame
M_s	Bending section capacity in pure bending
M*	Bending action
n	Strain hardening exponent
P_b	Buckling load
P_{crl}	Critical elastic buckling load
Q_k	Variable load

r_x	Rotation at x-axis
r_y	Rotation at y-axis
r_z	Rotation at z-axis
V*	Shear action
V_v	Shear capacity in pure shear
ν	Poisson's ratio
x	Story drift
δ	Deflection
ρ	Density
γ_G	Partial factors for permanent actions
σ	Stress
γ_Q	Partial factors for variable actions
Θ	Torsional rotation

ANALYSIS STRUKTUR DAN REKABENTUK KERANGKA RUMAH KELULI DENGAN TERBENTUK SEJUK DAN SIAP PANAS BAHAGIAN SEGI EMPAT TEPAT

ABSTRAK

Kajian ini membentangkan kelakuan struktur sistem kerangka keluli terbentuk sejuk untuk perumahan mampu milik. Objektifnya adalah untuk mengkaji tingkah laku sistem kerangka struktur keluli terbentuk sejuk dan keluli siap panas yang menggabungkan dinding beban, papak beban ringan dan untuk membandingkan berat bahan yang digunakan pada struktur keluli terbentuk sejuk dan keluli siap panas bagi perumahan mampu milik. Empat jenis model yang terdiri daripada 243 bahagian digunakan untuk menganalisis sistem rangka struktur keluli. Model 1 adalah sistem kerangka struktur keluli terbentuk sejuk dan Model 2 adalah sistem kerangka struktur keluli siap panas. Kedua-dua struktur keluli menggunakan panel dinding ringan dan papak komposit ringan. Model 3 dan Model 4 juga sistem kerangka struktur keluli terbentuk sejuk dan sistem kerangka struktur keluli siap panas. Kedua-dua struktur ini menggunakan bahan yang berbeza dari dinding dan papak yang merupakan dinding bata dan pratuang konkrit bertetulang. Semua model disediakan dalam AutoCAD dan dianalisis menggunakan perisian STAAD.Pro. Kajian ini mendapati bahawa bahagian nipis keluli boleh meningkatkan nilai pesongan. Peningkatan panjang bahagian dan nisbah kelangsingan akan mengurangkan rintangan tujahan. Apabila beban yang digunakan meningkat, ubah bentuk lengkokan juga meningkat. Selain itu, penurunan rintangan ricih disebabkan oleh penurunan kawasan ricih. Bahagian tebal dan bahan ringan yang digunakan dapat mengurangkan nilai putaran kilasan. Selain itu, perbandingan berat struktur keluli menunjukkan bahawa struktur keluli terbentuk

sejuk dengan panel dinding ringan dan papak komposit ringan adalah model terbaik kerana berat ringan dan lebih banyak manfaat untuk perumahan yang mampu dimiliki.

STRUCTURAL ANALYSIS AND DESIGN OF STEEL-FRAMED HOUSE WITH COLD-FORMED AND HOT-FINISHED RECTANGULAR HOLLOW SECTION

ABSTRACT

This study presents the structural behaviour of cold-formed steel framing system for affordable housing. The objectives are carried out to study the behaviour of cold-formed steel structural framing system incorporating lightweight load bearing wall and slab and to compare the weight of the material used on the cold-formed steel structural of affordable housing. Four types of model that consist 243 members are used to analyse the steel structural framing system. Model 1 is cold-formed steel structural framing system and Model 2 is hot-finished steel structural framing system. Both of steel structures utilizing lightweight wall panel and lightweight composite slab. Model 3 and Model 4 are also cold-formed steel structural framing system and hot-finished steel structural framing system. Both of this structures using the different materials of walls and slab which are brick wall and precast reinforced concrete. All of the models are drawn in AutoCAD and analysed using STAAD.Pro software. This study found that the thinner of steel section can increase the value of deflection. The increasing of the member length and ratio of slenderness will decrease the buckling resistance. When the applied load increases, the buckling deformation is also increase. Besides that, the decreasing of the shear resistance is caused by the decreasing of the shear area. The thicker section and the lightweight material used can decrease the torsional rotation value. Other than that, the weight comparison of the steel structure shows that cold-formed steel structure with lightweight wall panel and lightweight composite slab is the best model due to light weight and more benefits for affordable housing.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Nowadays, residential buildings are necessary and get attention due to the increasing of community in a nation. It is important as a shelter, gathering and comfort to stay for daily life. Steel framing system using cold-formed steel have been used in the construction of residential building to overcome the economy issue. Kumar and Kumar (2006) stated that light gauge steel is also called as cold-formed steel. Many countries like America, Europe Australia and New Zealand use the material in building construction industry (Authority, 2003). Structural steel framing is defined as steel skeleton that are made up of both horizontal beams and vertical columns. The function of the skeleton is to provide the support for the walls, roof, and floors of the structure (Buildipedia.com, 2009). Beam and column joined by the connections that consist of self-drilling screws, bolts and anchors. Figure 1.1 shows the example of structural framing system using light gauge material for residential building.

Figure 1.1: Example of structural framing system using light gauge material for residential building (Authority, 2003)

Hancock (2003) defined that cold-formed steel structures are bending flat sheets of steel at ambient temperature produces the products of steel structural into shapes that will support more than the flat sheets themselves. Since the first flat sheets of steel were produced by the steel mills, they have been produced for more than a century (Hancock, 2003). Cucu (2015) is also said cold-forming is an industrial process based on brake-forming and cold-rolling that able to be used to generate the different section shapes starting from a simply flat steel panel. The applications of cold-formed steel in building construction are structural members, roofs, walls, and floors. Kyvelou et al. (2017) had shown that cold-formed steel floor beams are appropriate to be used in flooring system. Structural members can be used in various shapes of cold-formed such as closed sections, built-up sections, open sections, and double channel I-sections. The use of the materials and the use of energy can be decreased by using the thin elements for the structures. This matter has shown that the use of natural resources like trees can be minimized and it is crucial to protect and preserve our natural resources. Therefore, cold-formed steel structures indicate a good alternative to classic way of construction (Cucu, 2015). Figure 1.2 is the cold-formed steel section for single open sections, open built-up sections, and closed built-up sections.

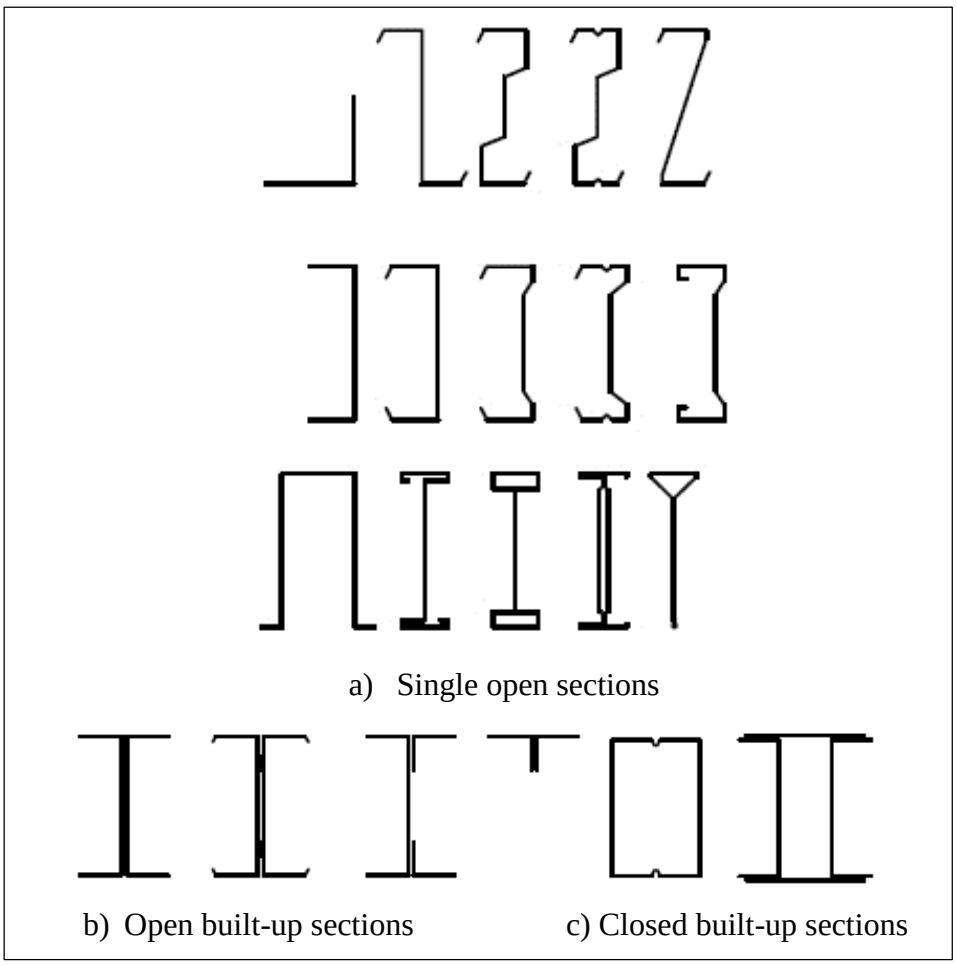

Figure 1.2: Cold-formed steel section (Dubina et al., 2012)

Furthermore, cold-formed steel has many advantages in building construction compared to the others construction materials. The main advantage is strong but lightweight due to the strength-to-weight ratios of any construction material (Authority, 2003). Lightness can ease on-site handling during construction and transportation and it is also be able to save in foundation needed. Material waste and site works can be decreased by using the pre-fabricated and preassembled steel components as well as it can improves quality of the steel structures. Other than that, termites and rotting problem can be avoided due to the durability of cold-formed steel. Steel has good fire resistance it is categorized as non-combustible material. So, it will not lead the fuel to spread of a fire. Besides that, all steel products can be reused and